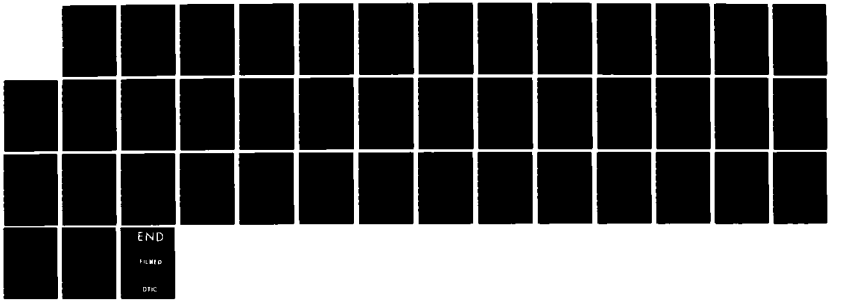
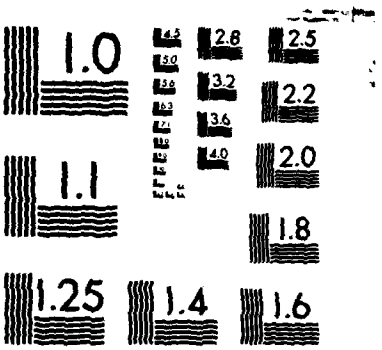
AD-A157 461 VALIDATION OF THE ALGORITHM FOR DEPOT TCTO LABOR COSTS FOR THE COMPONENT.. (U) INFORMATION SPECTRUM INC ARLINGTON VA S J EINHORN 12 APR 84 ISI-V-83-31859-12 1/1

UNCLASSIFIED F33600-82-C-0543 F/G 5/1 NL





INFORMATION SPECTRUM, INC.
1745 S. JEFFERSON DAVIS HIGHWAY, ARLINGTON, VIRGINIA 22202 (703) 892-9000

VALIDATION OF THE ALGORITHM FOR DEPOT TCTO LABOR COSTS FOR THE COMPONENT SUPPORT COST SYSTEM (D160B)

Contract No. F33600-82-C-0543

12 April 1984

Report Number
V-83-31859-12

Submitted to:

HEADQUARTERS
AIR FORCE LOGISTICS COMMAND
MML (VAMOSC)
WRIGHT-PATTERSON AFB, OH 45433

Prepared by:

Sheldon J. Einhorn

Dr. Sheldon J. Einhorn
Chief Scientist

CORPORATE OFFICE:
1040 KINGS HIGHWAY NORTH
CHERRY HILL, N.J. 08034
(609) 667-6161

3993 HUNTINGDON PIKE
HUNTINGDON VALLEY, PA. 19006
(215) 947-6060

EXECUTIVE SUMMARY

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system. VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force data systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for aircraft and engines.

The CSCS receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two standard reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests.

Special requests for data in user selected format may also be satisfied on a case by case basis.

At the heart of the CSCS is a set of 30 algorithms for estimation or allocation of costs. Information Spectrum, Inc. (ISI) was awarded a contract to validate these algorithms. This effort included investigations of logic, appropriateness of the algorithms and assumptions inherent in the algorithms. ISI was also to survey published findings, reports of audit, etc. relating to the accuracy of the source data systems. In addition to the algorithm validation, ISI was to perform certain "special tasks," including a user survey.

This report provides the verification and validation of the algorithm called "Depot TCTO Labor Costs." The costs of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technical Orders (TCTOs), which are "directives issued to provide instructions to Air Force Activities for accomplishing 'one-time' changes, modifications, or inspections of equipment or installation of new equipment." The CSCS algorithm for Depot TCTO Labor Cost calculates and presents depot TCTO labor costs separately from other direct labor costs. These costs are developed for each combination of aircraft MDS and depot. Base TCTO labor costs were discussed in an earlier report.

Some TCTO actions are identified as modifications. Existing Air Force data systems identify depot labor costs for modifications directly, and the CSCS uses these values.

For depot TCTO actions which are not modifications, the method is a little less direct. Total TCTO manhours and modification TCTO manhours at the depot level are available. Their difference, representing "other" TCTO manhours, is multiplied by an average depot labor rate representative of the depot and aircraft MDS of interest, yielding an estimated cost of depot TCTO actions other than modifications.

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were than applied to each algorithm. This report first describes the analysis procedures, without reference to the specific algorithm addressed by this report.

Next, the Depot TCTO Labor Cost algorithm is defined and described in detail. This description includes identification of source data systems and files, and the calculation procedures currently implemented by the CSCS.

Finally, a critique of the algorithm is provided as required by the contract. It addresses the following topics:

- Verification of assumptions and approximations for appropriateness and accuracy.
- Validation of accuracy of source data.
- Validation of appropriateness of source data as inputs to CSCS logic.
- Investigation of accuracy and appropriateness of algorithms.
- Consideration of replacement of indirect cost methods with more direct ones.

- o Identification of algorithm impact on CSCS output reports.

For each algorithm addressed, ISI is required to affirm the process or procedure and reject any portion that cannot be affirmed. Where the algorithm or portion of the algorithm is rejected, an alternate procedure must be specified.

For the Depot TCTO Labor Cost algorithm, all aspects are affirmed. It is recommended that the algorithm be retained in its present form.

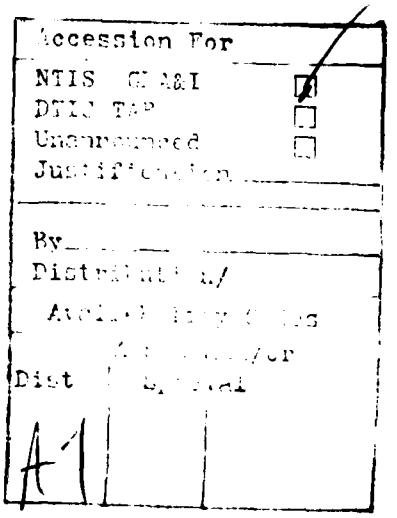


TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system (all costs are computed and portrayed in "then year" dollars). VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

1.1 The Component Support Cost System

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for

aircraft and engines.

The objectives of the Component Support Cost System are:

(1) To improve the visibility of aircraft and engine component support costs and to relate those costs to the end item or weapon system.

(2) To improve the Life Cycle Costing capability for the Air Force and the Department of Defense in the acquisition of new weapon systems.

(3) To assist in the design of new weapon systems by providing cost information on existing weapon systems, thereby enhancing design tradeoff studies.

(4) To provide historical cost information at the weapon system level to improve logistic policy decisions.

(5) To identify system component reliability, effectiveness, and costs so that high support cost items may be identified and addressed.

The CSCS is described in detail in references [1], [2], and [3]. It receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two mandatory reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests. Special requests for data in user selected format may also be satisfied on a case by case basis.

The twelve reports mentioned above are of primary interest

to the user community. They are identified by name in Table 1. Descriptions and samples are provided by reference [1].

TABLE 1. CSCS OUTPUT REPORTS

NUMBER*	Name
8105	Cost Factors
8104	MDS Logistics Support Costs
8106	Base Work Unit Code (WUC) Costs
8107	Total Base Work Unit Code (WUC) Costs
8111	Depot On-Equipment Work Unit Code (WUC) Costs
8108	Total Base and Depot Work Unit Code (WUC) Costs
8109	NSN-MDS-WUC Cross-Reference
8110	MDS-WUC-NSN Cross-Reference
8112	Logistic Support Cost Ranking, Selected Items
8113	Summary of Cost Elements
8114	NSN-WUC Logistics Support Costs
8115	Assembly-Subassembly WUC Costs

*CSCS output reports are assigned Report control Symbol HAF-LEY (AR)nnnn, where nnnn is the number in the table.

At the heart of the CSCS is a set of 30 algorithms for estimation or allocation of costs. The algorithms are identified by name in Table 2. Information Spectrum, Inc. (ISI) was awarded a contract to validate these algorithms. This effort included investigations of logic, appropriateness of the algorithms and assumptions inherent in the algorithms. ISI was also to survey published findings, reports of audit, etc. relating to the accuracy of the source data systems. In addition to the algorithm validation, ISI was to perform certain "special tasks," including a user survey.

1.2 Overview of the Algorithm

This report provides the verification and validation of algorithm 18 of Table 2, "Depot TCTO Labor Costs." The cost of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technicl Orders (TCTOs), which are "directives issued to provide instructions to Air Force activities for accomplishing 'one-time' changes, modifications or inspections of equipment or installation of new equipment," (reference [12]). The CSCS calculates and presents TCTO labor costs separately from other direct labor costs. These costs at the depot level are provided separately for each combination of aircraft MDS and base. Base TCTO labor costs were discussed in reference [17].

Some TCTO actions are identified as modifications. Existing Air Force data systems identify depot labor costs for modifications

TABLE 2. CSCS ALGORITHM NAMES

1. Base TCTO Labor Cost
2. Base TCTO Overhead Cost
3. Base TCTO Material Cost
4. TCTO Transportation Costs
5. Base Inspection Costs
6. Base Other Support General Costs
7. Base Labor Costs
8. Base Direct Material Costs
9. Base Maintenance Overhead Costs
10. Second Destination Transportation Costs
11. Second Destination Transportation Costs (Engine)
12. Base Exchangeable Repair Costs (NSN)
13. Base Exchangeable Repair Costs (Engine)
14. Base Exchangeable Modification Costs (NSN)
15. Base Condemnation Spares Costs/NSN
16. Base Exchangeable Modification Costs (Engine)
17. Base Supply Management Overhead Costs
18. Depot TCTO Labor Costs
19. Depot TCTO Material Costs
20. Depot TCTO Other Costs
21. Depot Support General Costs
22. Depot Labor Costs
23. Depot Direct Material Costs
24. Depot Other Costs
25. Depot Exchangeable Repair Costs (NSN)
26. Depot Exchangeable Repair Costs (Engine)
27. Depot Exchangeable Modification Costs (NSN)
28. Depot Exchangeable Modification Costs (Engine)
29. Depot Condemnation Spares Costs (NSN)
30. Depot Material Management Overhead Cost

directly, and the CSCS uses these values.

For depot TCTO actions which are not modifications, the method is a little less direct. Total TCTO manhours and modification TCTO manhours at the depot level are available. Their difference, representing "other" TCTO manhours, is multiplied by an average depot labor rate representative of the depot and aircraft MDS of interest, yielding an estimated cost of depot TCTO actions other than modifications.

2.0 ANALYSIS PROCEDURES

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were then applied to each algorithm. This section describes the analysis procedures without reference to the specific algorithm addressed by this report.

The algorithm analysis process consists of five portions, described in the following sections.

2.1 Algorithm Description

The algorithms are described in references [1], [2], and [3]. These descriptions are not identical. In general they supplement, rather than contradict each other. The first two describe what the system is to achieve; the third describes the system design to do so.

None of these descriptions provides the combination of level of detail and clarity of concept required for this validation effort. The first step in the analysis methodology was the generation of such a description. The descriptions in the three reference sources just cited were studied. Assumptions about data processing procedures were made explicit. When necessary, Air Force personnel involved in implementation of the D160B subsystem were contacted for clarification.

2.2 Input Data Definitions

Closely related to the first step was the clarification of

the definitions of the input data. The identification of each input data element and of the system providing it was provided by the User's Manual (reference [1]). This identification was refined by identification of a particular file within the source system and the structure of the file as described in both the CSC System/Subsystem Specification and in the Memoranda of Agreement. The Memoranda of Agreement have been established between the Office of VAMOSC and the Offices of Primary Responsibility (OPR) for the systems providing the input data. Any inconsistencies or voids were identified and resolved through contact with the Office of VAMOSC and/or implementing personnel.

Whenever appropriate, input data element definitions were further refined by tracing the elements back to their sources through the reference data provided. If these were inadequate, the OPRs were contacted directly for clarifications. In tracing the data back to their origins, possible sources of data contamination were considered. Information on the likelihood and significance of such contamination was collected from cognizant personnel and from published references.

2.3 Concept Validation

The two steps above established exactly what the algorithm does. The third, and most critical step, considered the validity of the procedure. It depended on the ability of the analyst to translate mathematical formulas and data processing techniques into meaningful concepts.

Some explicit techniques which were generally used in concept validation are listed below.

(a) Consider how the cost element would be calculated if there were no constraints on resources. (For example, suppose the CSCS could identify the pay grade and hours worked of each individual involved in a maintenance action.)

(b) Identify assumptions* incorporated into the Algorithm. Generally this procedure will identify the real constraints which affect the approach in (a) above.

(c) Identify approximations incorporated into the algorithm. For instance, one such approximation is the use of an average labor rate for each aircraft.

(d) Study each approximation for possible sources of error. Some examples are biases introduced by editing procedures, obsolete data, or inappropriate application. Whenever feasible, estimate the likelihood of these errors by reviews of the literature and contact with cognizant personnel.

(e) Test the algorithms under conditions of assumed extreme values for the inputs. For instance, in evaluating the algorithm for base maintenance overhead costs, assume

---

*Note that assumptions, approximations, and allocations are different concepts, although in some cases the boundaries between them are not sharp. ISI has recognized few assumptions in the algorithms, but many approximations and allocations.

that for a single reporting period all maintenance labor is overhead and none is direct. Also try the reverse assumption. If an assumption of an extreme input leads to an illogical result, the algorithm is flawed.

General Task (4) of Section C-2, of the contract speaks of appropriate statistical techniques to confirm or repudiate each algorithm. Statistical techniques could confirm or repudiate only statistical hypotheses as assumptions. (Use of an average does not constitute an assumption.) Accordingly, statistical techniques apply to confirmation or repudiation of an algorithm only to the extent that statistical hypotheses can be developed.

(f) As each algorithm is considered, ensure that the costs do not overlap others already accounted for. (In some cases an overlap may be necessary and desirable. Where this occurs, the overlap will be noted.)

(g) In each CSCS output report, identify the data elements incorporating the output of the algorithm, so that a final assessment of report accuracy can be made for each output report.

(h) Consider alternative sources of input data for the algorithm. Also consider more direct cost assignments then those incorporated in the algorithm.

2.4 Problem Resolution

Whenever a significant deficiency was recognized in one of the algorithms, one or more proposed solutions were developed. This was a creative analytic process for which few guidelines could be proposed in advance. Certainly it depended on familiarity with the various existing Air Force data reporting and processing systems. Proposed solutions were discussed with personnel of the Office of VAMOSC, and revised as appropriate. Recommended solutions were expressed in the form of contributions to a draft Data Automation Requirement (DAR) when these would be applicable.

2.5 Documentation

The documentation of the analysis of each algorithm was a crucial part of the effort. Emphasis was placed on making it thorough, clear, and unambiguous. In the documentation, every assertion was substantiated. This was done by reference to source documentation, by explicitly expressed application of the experience and judgment of the contractor, or by citation of information provided by cognizant Air Force personnel. In the last case, the information was supported by documentation identifying the source, the date, and the information provided.

3.0 ALGORITHM ANALYSIS

The previous section described the general analysis procedures applied to all algorithms. This section presents the results of applying those procedures to the algorithm for Depot TCTO Labor Costs.

Section 3.1 provides a detailed description of the algorithm and of the input data it uses. Section 3.2 provides a critique, structured to correspond to the contractual requirements. Section 4.0 makes recommendations for solutions of problems.

3.1 Algorithm Description

In the following description, COBOL-type data names are used to express the algorithm output and its components. The available source documentation does not provide the actual data names used by the CSCS programs. They are presumably different from those used in this report.

There are three kinds of TCTO actions: Class IV modifications, Class V modifications, and "other." The three kinds are explained in Section 3.1.3 below. Although the User's manual identifies a single algorithm as "Depot TCTO Labor Costs," in fact the CSCS calculates and presents labor costs separately for the three cases.

The calculation formulas are stated in Section 3.1.1. The input data elements and their sources are provided in Section 3.1.2. The calculation is described verbally in Section 3.1.3.

Unless otherwise noted, the descriptions are based on references [1], [2], and [3], and on direct discussion with personnel of the Office of VAMOSC. In case of any discrepancies, information provided by knowledgeable personnel was accepted as most current, hence most definitive.

3.1.1 Calculations

Two kinds of depot TCTO labor costs are not "calculated," they are simply aggregated from the input data system. These two, identified here as CLS-IV-LABOR and CLS-V-LABOR, are aggregated as described in Sections 3.1.2 and 3.1.3. It is convenient to express the remaining calculations by three formulas:

(1) DEPOT-MDS-LABOR-RATE

$$= \frac{\text{CIV-PROD-COST + CIV-OTH-COST + MIL-PROD-COST + MIL-OTH-COST}}{\text{CIV-PROD-MH + MIL-PROD-MH}}$$

(2) DEPOT-TCTO-OTHER-MH

= DEPOT-TCTO-MH - DEPOT-CL-IV-MH - DEPOT-CL-V-MH

(3) OTHER-TCTO-LABOR

= DEPOT-TCTO-OTHER-MH x DEPOT-MDS-LABOR-RATE

3.1.2 Inputs

Name: CLS-IV-LABOR

Definition: Cost of direct labor for Class IV modifications for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: CLS-V-LABOR

Definition: Cost of direct labor for Class V modifications for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: CIV-PROD-COST

Definition: Cost of military direct labor-production,(1) excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: CIV-OTH-COST

Definition: Cost of civilian direct labor-other,(1) excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: MIL-PROD-COST

Definition: Cost of military direct labor-production,(1) excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: MIL-OTH-COST

Definition: Cost of military direct labor-other,(1) excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: CIV-PROD-MH

Definition: Civilian direct labor-production (1) man-hours, excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

---

(1) See discussion in Section 3.1.3

Name: MIL-PROD-MH

Definition: Military direct labor-production (1) man-hours, excluding modification actions, for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: DEPOT-TCTO-MH

Definition: Total (civilian and military) direct labor man-hours for TCTO for the selected depot, MDS, and calendar quarter.

Source System/File: D056A/MNI75A0

Name: DEPOT-CL-IV-MH

Definition: Total (civilian and military) direct labor production man-hours for Class IV for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

Name: DEPOT-CL-V-MH

Definition: Total (civilian and military) direct labor man-hours for Class V for the selected depot, MDS, and calendar quarter.

Source System/File: H036B/AHMORA1

3.1.3 Description of Calculation Procedure

The calculation procedure reflects the structure of the data collected by the H036B data system. That structure is established by reference [29]. Table 3 lists the cost and labor hour data elements collected by the H036B data system. The element numbers are as used in CSCS files, from which this table was extracted.

---

(1) See discussion in Section 3.1.1.

TABLE 3. H036B COST AND LABOR HOUR DATA ELEMENTS

Number (1)	NAME
024	COST, PRODUCTION, DIRECT LABOR, CIVILIAN
025	HOURS, PRODUCTION, DIRECT CIVILIAN LABOR
026	COST, OTHER, DIRECT LABOR, CIVILIAN
027	HOURS, OTHER, DIRECT CIVILIAN LABOR
028	COST, PRODUCTION, DIRECT LABOR, MILITARY
029	HOURS, PRODUCTION, DIRECT MILITARY LABOR
030	COST, OTHER, DIRECT LABOR, MILITARY
031	HOURS, OTHER, DIRECT MILITARY LABOR
032	COST, FUNDED, DIRECT MATERAL
033	COST, UNFUNDED, DIRECT MATERIAL INVESTMENT
034	COST, UNFUNDED, DIRECT MATERIAL EXCHANGE
035	COST, UNFUNDED, DIRECT MATERIAL, MODIFICATION KITS
036	COST, UNFUNDED, DIRECT MATERIAL EXPENSE
037	COST, FUNDED, OTHER DIRECT
038	COST, UNFUNDED, OTHER DIRECT
039	COST, FUNDED, OPERATIONS OVERHEAD
040	COST, UNFUNDED, OPERATIONS OVERHEAD
041	COST, FUNDED, GENERAL AND ADMINISTRATIVE
042	COST, UNFUNDED, GENERAL AND ADMINISTRATIVE
043	COST, CONTRACT OR INTERSERVICE
044	COST, GOVERNMENT FURNISHED MATERIAL, INVESTMENT
045	COST, GOVERNMENT FURNISHED MATERIAL, EXCHANGE
046	COST, GOVERNMENT FURNISHED MATERIAL, MODIFICATION
047	COST, GOVERNMENT FURNISHED MAERIAL, EXPENSE
048	COST, FUNDED, GOVERNMENT FURNISHED SERVICES
049	COST, UNFUNDED, GOVERNMENT FURNISHED SERVICES
050	COST, FUNDED, MAINTENANCE SUPPORT
051	COST, UNFUNDED, MAINTENANCE SUPPORT

(1) As used in CSCS files.

Each H036B data record identifies a Work Performance Category and a Work Breakdown Structure. The codes for each of these data elements are provided in Appendix A. Only the Work Breakdown Structure Codes for aircraft (first character = "A") are provided.

Reference [12], citing AFLCR 171-24, defines a Class IV modification as "a modification necessary to correct equipment deficiency or installation deficiency that affects maintainability or reliability (flight safety or reliability). It defines a Class V modification as "a modification required to improve system operational capability (change in mission)." In practice, Air Force personnel agree, Class IV modifications are assigned Work Performance Category code "H", and Class V modifications are assigned code "C." All modifications are classified as either Class IV or Class V.

With the help of the H036B data fields described above, and others, the costs of direct labor for depot Class IV modifications are aggregated as follows. Records are selected from H036B meeting the following criteria:

(a) The first character of the Work Breakdown Structure Code is "A," identifying an aircraft.

(b) The third character of the Work Breakdown Structure Code is not "2," eliminating engines.

(c) The item identification code includes alphabetic characters, thus identifying an entire aircraft, as opposed to a component.

(d) The Work Performance Category code is "H," identifying a Class IV modification.

(e) The desired calendar quarter is coded.

For all such records, the costs of civilian production direct labor, civilian other direct labor, military production direct labor, and military other direct labor are summed. These sums are accumulated separately for each combination of depot and MDS.

The procedure for accumulating the costs of direct labor for Class V modifications is exactly the same, except that the Work performance Category code is "C" instead of "H."

There are aircraft TCTO actions other than modifications. Section 2-5 of reference [32] describes inspection TCTOs, which may involve repair, but which does not change form, fit, or function. The H036B data system does not distinguish such depot activities from non-TCTO actions. Accordingly, the CSCS approach to costing "other" TCTO actions is less direct.

First, for each combination of MDS and depot, a depot labor rate is established, as follows. The total direct labor costs for all repair actions <u>other</u> than modifications are accumulated. This is the same process as for modifications, except that the Work performance Category codes are A, B, G, I, J, or K.(1) The total combined military and civilian production hours are accumulated for the same records. In formula (1) of Section 3.1.1 the

(1) See Appendix A.

costs are divided by the hours, yielding the average depot non-modification direct labor cost per production hour.

The Maintenance Data Collection System (D056) identifies TCTO production man-hours at the depot level. These are accumulated by depot and MDS for the desired quarter. The H036B system identifies production man-hours, military and civilian, identifiable to Class IV and Class V modifications. These, of course, are accumulated by the CSCS programs at the same time it is accumulating the Class IV and Class V modification costs. In formula (2) of Section 3.1.1, the modification production man-hours are subtracted from the total TCTO production man-hours. The result, accumulated separately for each combination of depot and MDS, is the production man-hours for "other" (non-modification) TCTO actions.

Finally, in formula (3), these man-hours are multiplied by the average labor rate, yielding for each depot and MDS an estimate of the cost of "other" TCTO direct labor.

3.2 Critique of Algorithm

This section addresses various facets of the algorithm. The discussion is structured to correspond to the contractual requirements. Each aspect is either affirmed or rejected. Rejections lead to recommendations in Section 4.0.

3.2.1 Appropriateness and Accuracy of Assumptions and Approximations

Information Spectrum has identified one approximation used in the Depot TCTO Labor Costs algorithm. The approximation is the

use of the average (non-modification) depot labor cost rate in order to estimate non-modification TCTO labor costs. The average rate is based on depot activities which may include many non-TCTO actions. This approximation implicitly assumes that the actual average labor rate for non-TCTO activities is the same as the rate for non-modification TCTO activities. Information Spectrum can see no feasible way to verify this assumption, nor any reason to doubt it. Moreover, a future report will show that the algorithm for depot direct labor costs for non-TCTO maintenance uses the same approximation, so that the two algorithms taken jointly provide an exact, not approximate, evaluation of labor costs. Hence we affirm the appropriateness and accuracy of the approximation.

3.2.2 Accuracy of Source Data and Congruence of Data Element Definitions

Information Spectrum was directed to validate accuracy of source data based on survey of published findings, reports of audit, etc. No direct sampling of data was to be performed. The Office of VAMOSC has indicated that direct validation of source data is planed for future efforts.

The source data for this algorithm comes from two data systems. Labor cost and labor hour data come from H036B. Other labor hour data comes from D056. No published criticism of the former could be found. Criticisms of D056 have addressed only base level data collected through the Maintenance Data Collection

System, not depot level data. Accordingly, the accuracy of the source data is affirmed.

The definitions of direct labor hours and costs used in H036B derive directly from Section 32004 of reference [29]. That reference establishes "direct labor-production" and "direct labor-other" as encompassing all direct labor costs. It also defines direct labor-production as "those production operations which are performed in sequence and normally have established time standards ... Included are operators of heat treating, plating, and painting equipment; excluded are material handlers who deliver and preposition repair parts and supplies for subsequent use." This corresponds to D056 labor, commonly referred to as "hands-on" or "wrench turning" labor as provided by the source systems and as used by the CSCS.

3.2.3 Appropriateness of Source Data as Inputs

In the case of direct labor costs for Class IV and Class V modifications, the inputs to the algorithm are also the outputs. The costs are reported directly, hence they are obviously appropriate. The H036B data system is designed to provide depot cost data in accordance with the requirements of reference [29], and the inputs are entirely appropriate for developing depot direct labor rates. Finally, given the approach to development of "other" TCTO depot labor costs, the D056 system is an appropriate source for depot labor hours. Thus we affirm the appropriateness of all source data as inputs.

3.2.4 Accuracy and Appropriateness of Algorithm

In developing the labor costs for modifications, as previously explained, the algorithm aggregates, not calculates, the results. Thus, within the constraints of reporting accuracy, the algorithm is entirely accurate and appropriate.

Since "other" TCTO manhours are not directly reported, it is appropriate to use an approximation. The average depot labor rate developed as described in Section 3.2.1 is considered appropriate by ISI, and accurate. As previously remarked, the sum of TCTO "other" depot labor costs and depot MDS non-TCTO labor costs is necessarily accurate. ISI affirms the accuracy and appropriateness of the algorithm.

3.2.5 Directness of Costing

The depot modification labor costs are perfectly direct. The labor costs for "other" TCTO labor are as direct as appear to be achievable. Hence the directness of costing of the algorithm is affirmed.

3.2.6 Application to CSCS Output Reports

Depot TCTO labor costs are components of five CSCS reports, as described by Table 4. The accuracy of the algorithm output will impact the accuracy of the reports as a whole. However, the total report accuracy cannot be addressed until all algorithms are reviewed. This will occur in the final report of this effort. Evaluation of the usefulness of the report will also be provided in the final report of this effort and after ISI conducts a survey of users.

TABLE 4

CONTRIBUTION OF DEPOT TCTO LABOR COST ALGORITHM TO CSCS OUTPUT REPORTS

OUTPUT REPORT/NUMBER(1)	COST ELEMENTS CONTRIBUTED TO BY THE ALGORITHM(2)
1. MDS Logistics Support Costs/8104	1. Elements By MDS for all bases: a. TCTO COSTS (1) LABOR COSTS (a) DEPOT CLASS IV MODS (b) DEPOT CLASS V MODS (c) Depot Other Mods(3) (2) Labor Hours (a) DEPOT CLASS IV MODS (b) DEPOT CLASS V MODS (c) DEPOT OTHER MODS(3)
2. Cost Factors/8105	2. By MDS and ALC a. DEPOT AVERAGE COST PER HOUR, LABOR
3. Total Base and Depot Work Unit Code (WUC) Cost Report/8108	3. By MDS a. TOTAL COSTS, TCTO(4)
4. Depot On-Equipment Work Unit Code (WUC) Costs/8111	4. By MDS and ALC a. DEPOT TOTAL COSTS, TCTO(4)
5. Summary of Cost Elements/8113	5. By MDS a. CLASS IV MODIFICATIONS, DEPOT TCTO COSTS, LABOR

(1) CSCS output reports are assigned Report Control Symbol HAF-LEY (AR) nnnn, where nnnn is the number in the table.

(2) Capital Letters indicate the titles printed on the report.

(3) Misnomer. Should be titled "Depot Other".

(4) Misnomer. Only modification costs are reported.

4.0 RECOMMENDATIONS

Section 3 has reviewed the Depot TCTO Labor Cost Algorithm. All aspects of the algorithm have been affirmed. Information Spectrum recommends that it be retained in its present form.

4.0A Office of VAMOSC (00V) Comments

Concur.

REFERENCES

[1] AF Regulation 400-31, Volume IV (6 August 1982), Visibility and Management of Operating and Support Cost Program (VAMOSC) Component Support Cost System (CSCS)

[2] FD-K-14010C, Functional Description (for the Component Support Cost System (CSCS), Data System Designator D160B, undated draft)

[3] SS-K-15010B, Component Support Cost System/Subsystem Specification, 1 June 1983

[4] TO-00-20-2, Technical Manual: The Maintenance Data Collection System, 1 November 1981

[5] TO-00-20-2-45-2, Operational Supplement to Technical Order: Maintenance Documentation for In-Shop Engine Maintenance, 1 October 1982

[6] Memoranda of Agreement (listed separately)

[7] Letter from Chief, Material, Cost & International Accounting Systems Division, Directorate of Plans & System, HQ USAF, dated 27 Feb 1981, Subject: Direct Labor Rates

[8] Air Force Magazine, May 1983 (Almanac Issue)

[9] AFLC Pamphlet 173-10, AFLC Cost and Planning Factors, 31 December 1981

[10] "A Statistical Evaluation of the Accuracy of Maintenance Direct Labor Data Used in Support of Operating and Support Costs." Desmatics, Inc. Final Report No. 111-1, by Dennis E. Smith, Robert L. Gardner, and Terry L. King, April 1979

[11] "The Air Force Can Improve Its Maintenance Information System," U.S. General Accounting Office Report No. GAO/GGD-83-20, 25 January 1983

[12] Compendium of Authenticated Systems and Logistics Terms, Definitions and Acronyms, School of Systems and Logistics, Air Force Institute of Technology, 1 April 1981

[13] AF Regulation 177-101, General Accounting and Finance Systems at Base Level, 17 March 1980 updated to 1 June 1982

[14] AF Manual 177-380, USAF Standard Base Level Maintenance Cost System (B3500), 19 October 1976 updated to 31 July 1981

[15] AF Regulation 173-13, USAF Cost and Planning Factors, 1 February 1982

[16] HQ USAF/ACF (AFAFC) Denver, Co ltr (undated), Subject: Direct Labor Rates for VAMOSC (your 21 Apr 83 ltr)

[17] "Validation of the Algorithm for Base TCTO Labor Cost for the Component Support System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-01, 15 August 1983

[18] AF Regulation 300-4, Vol. III, Unclassified Data Elements and Codes, 1 May 1982

[19] AF Manual 177-674, USAF Standard Base Level Accounting and Distribution System (AFDS): H069R/XQ (H6000), 1 April 1980, updated to 18 June 1982

[20] AF Manual 177-370, USAF Standard Base-Level Accounting and Finance System (B3500), 1 December 1979

[21] TO-00-20-2-2, Technical Manual: On-Equipment Maintenance Documentation for Aircraft; Air-Launched Missiles; Ground-Launched Missiles; Except ICBMS; Drones; and Related Training Equipment, 1 August 1976, updated to 15 October 1982

[22] TO-00-20-2-10, Technical Manual: Off-Equipment Maintenance Documentation for Shopwork, Conventional Munitions, and Precision Measuring Equipment, 1 January 1978, updated to 1 August 1982

[23] AF Manual 66-267, Maintenance Data Collection System (MDC), DSDC: G001BD, Users Manual, 1 October 1979, updated to 1 January 1983

[24] Letter from Chief, Material Systems Division, Directorate of Comptroller Systems, Air Force Data Systems Design Center, to HQ AFLC/MM(VAMOSC), dated 15 September 1983, Subject: "D002A, Daily Consumable Material Cost Data Interface with D160B, Component Support Cost System (CSCS) (your ltr, 15 Aug 83)."

[25] AF Manual 67-1, USAF Supply Manual, Vol. II, Part I, Base Procedures, updated to 18 April 1983

[26] AFLC Regulation 72-2, Cataloging and Standardization, 3 March 1980, updated to 29 May 1982

[27] "Validation of the Algorithm for Base TCTO Overhead Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-02, 15 August 1983

[28] "Validation of the Algorithm for Base Labor Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-06, 13 December 1983

[29] DoD Handbook 7220.29-H, Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Handbook, updated through 13 September 1979

[30] AF Manual 400-1, Volume II, Comprehensive Engine Management System (D042) Engine Status, Configuration and TCTO Reporting Procedures, 1 October 1983

[31] "Validation of the Algorithms for Base Exchangeable Repair Costs (Engine) and Base Exchangeable Modification Costs (Engine) for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-10, 11 February 1984

[32] TO-00-5-15, Technical Manual: Air Force Time Compliance Technical Order System, 15 April 1983

[33] "Validation of the Algorithm for Depot TCTO Labor Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-12, 12 April 1984

[34] "Validation of the Algorithm for Depot TCTO Material Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-13, 12 April 1984

[35] "Validation of the Algorithm for Depot TCTO Other Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-14, 12 April 1984

[36] AFLC Regulation 170-10, "Depot Maintenance Service Air Force Industrial Fund (DMS, AFIF) Financial Procedures, 28 June 1979, updated to 16 February 1982

[37] "Validation of the Algorithms for Base Exchangeable Repair Costs (NSN) and Base Exchangeable Modification Costs (NSN) for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-09, 11 February 1984

[38] AF Manual 67-1, "USAF Supply Manual," Vol. II (Ph IV) Part II, 1 February 1984

[39] "Validation of the Algorithm for Base Maintenance Overhead Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-08, 13 December 1983

[40] "Aircraft Operating and Support Cost Development Guide," Office of the Secretary of Defense, Cost Analysis Improvement Group, 15 April 1980

[41] DoD 7220.29H, "DoD Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook," updated through 28 October 1981

[42] VAMOSC Operating Instruction 7, Component Support System (CSCS), Mission Support of the CSCS (D160B), 9 April 1982

[43] VAMOSC OI7, 28 December 1983

[44] AFLC Regulation 75-1, Shipment Processing and Documentation, 15 October 1975, updated to 21 December 1977

[45] AFM 400-1, Volume I, Selective Management of Propulsion Units, Policy and Guidance, 21 June 1976

[46] Aircraft Operating and Support Cost Development Guide, Office of the Secretary of Defense, Cost Analysis Improvement Group, 15 April 1980

[47] Letter from ACM to ALMAJCOM-SOA/ACM/ACC/ACR, Subject: Commercial/Industrial Type Activities (CITA) Factor Development Procedures (RCS: HAF-ACM(AR)8004) (AF/MPMX Msg, 251445Z Jul 80), signed by Donald G. Kane, Colonel, USAF, Director of Cost and Management Analysis

[48] AFLC Regulation 65-12, Management of Items Subject to Repair (MISTR). 2 August 1978

[49] AFLC Regulation 66-61, Operational Planning, 27 October 1983

[50] "Validation of the Algorithms for Depot Support General, Labor, Direct Material, and Other Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-15, 12 April 1984

[51] AF Manual 177-206, Automated Material System Interfaced with Supply System at Base Level, Users Manual, 1 August 1979, updated to 1 February 1983.

[52] AF Regulation 66-1, Maintenance Management, Volume 3, Squadron Maintenance, 2 January 1980

[53] "Validation of the Algorithm for Base Inspection Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-04, 15 August 1983

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES

Ref. No.	Memorandum No.	Date
[6.1]	D002A/M024B/D160B-A	9 Jun 1980
[6.2]	D002A/M024B/D160B-B	9 Jun 1980
[6.3]	D024A/D160B-A	30 Jun 1980
[6.4]	D033./ARC/D160B	14 Jun 1980
[6.5]	D042A/DNB/D160B	4 Nov 1983
[6.6]	D046/M024/D160B	9 Apr 1981
[6.7]	D046/D160B	23 Jun 1982
[6.8]	D056A/BDN/D160B-A	23 Jan 1981
[6.9]	D056A/D160B-C	13 Oct 1981
[6.10]	D056A/D160B-D	29 Jan 1981
[6.11]	D056A F005	25 Apr 1979
[6.12]	D056B/BDN/D160B-A	22 Dec 1980
[6.13]	D056C/D160B-A	4 Mar 1981
[6.14]	D071/D160B	17 Jun 1982
[6.15]	D143B/D002A 9159	3 Aug 1979
[6.16]	D143F/ARC/D160B-A	5 Feb 1981
[6.17]	D160/D160B	11 Jun 1982
[6.18]	G004L/M024B/D160B-A	30 May 1980
[6.19]	G004L/M024B/D160B-B	30 May 1980
[6.20]	G004L/M024B/D160B-C	5 Nov 1981
[6.21]	G019F/D160B	8 Sep 1982
[6.22]	G033B/D160B	12 Jul 1982
[6.23]	G072D/BDN/D160B-A	19 Apr 1982

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES (Continued)

Ref. No.	Memorandum No.	Date
[6.24]	H036B/RC/D160B-A	10 Feb 1981
[6.25]	H069R/M024B/D160B-B	19 Jan 1981
[6.26]	0013/BDN/D160B	22 Jul 1982

APPENDIX A

WORK PERFORMANCE CATEGORIES AND AIRCRAFT WORK BREAKDOWN STRUCTURE CODES

(Extracted from reference [1]

WORK PERFORMANCE CATEGORIES

Code A—Overhaul. The disassembly, test, and inspection of the operating components and the basic structure to determine and accomplish the necessary repair, rebuild, replacement and servicing required to obtain the desired performance. It is considered to be synonymous with the terms "rework" or "rebuild."

Code B—Progressive Maintenance. A predetermined amount of work that presents a partial overhaul under a program that permits the complete overhaul to be accomplished during two or more time periods. It is considered synonymous with the terms "cycle maintenance," "restricted availability," "preventive servicing," or "recondition."

Code C—Conversion. The alteration of the basic characteristics of an item to such an extent as to change the mission, performance or capability.

Code D—Activation. The depreservation, servicing, inspection, test and replacement of assemblies or subassemblies as required to return an item from storage or inactive pool status to operational use.

Code E—Inactivation. The servicing and preservation of an item prior to entering storage or an inactive pool.

Code F—Renovation. The proof and test evaluation and rework of ammunition or ordnance items as required for retaining their desired capability.

Code G—Analytical Rework. The disassembly, test and inspection of end-items, assemblies or subassemblies to determine and accomplish the necessary rework, rebuild, replacement, or modification required. It includes the technical analysis of the findings and determination of maintenance criteria. Includes prototype tear-down, analysis and rework of an item to determine job and material specifications on a future workload.

Code H—Modification. The alteration or change of the physical makeup of a weapon/support system, subsystem, component, or part in accordance with approved technical direction.

Code I—Repair. Action taken to restore to a serviceable condition an item rendered unserviceable by wear, failure, or damage.

Code J—Inspection and Test. The examination and testing required to determine the condition or proper functioning as related to the applicable specifications.

Code K—Manufacture. The fabrication of an item by application of labor and/or machines to material.

Code L—Reclamation. The authorized processing of end-items, assemblies or subassemblies to obtain parts or components that are to be retained in the inventory prior to taking disposal action on the remaining items. Covers demilitarization actions on items prior to disposal when the demilitarization is incidental to the reclamation.

Code M—Storage. The inspection, represervation and maintenance in a storage status of weapons and equipment items as well as their subsystems and components in the supply system.

Code N—Technical Assistance. The use of qualified depot maintenance personnel to provide technical information, instructions, or guidance, or to perform specific work requiring special skills, for operational activities or other maintenance organizations. Includes all demilitarization other than the incidental to reclamation (Code L)

Code O—Not Used.

Code P—Programming and Planning Support. Includes consolidated long-range workload scheduling and resource utilization; centralized maintenance programming and planning for support of all levels of maintenance; all logistics support exclusive of engineering effort in the programming and development of maintenance support requirements for weapon systems and weapons support activities.

Code Q—Maintenance Technical and Engineering Support. Includes the technical and engineering effort in development of maintainability concepts and the maintenance portion of logistics plans dealing with future and present weapons and equipment. Includes regional maintenance representatives, field liaison, maintenance technicians, contract technical services, contract engineering services in direct support of maintenance, contract technicians and engineers in direct support of maintenance.

Code R—Technical and Engineering Data. Includes the preparation of technical and engineering data as applied to all categories of equipment. Includes engineering drawings, wiring diagrams, technical orders, engineering technical standards, technical handbooks, technical bulletins and similar publications. Provides for the preparation, editorial review and/or revision of equipment publications pertaining to the operation, repair and repair parts support of DOD materiel. Preparation includes, but is not limited to, the consolidation of source data, drawings and art work, editing, preparation of final printable copy and printing. Includes significant identifiable effort within organic maintenance or at other DOD specialized support functions to produce data in support of maintenance, such as cryptographic or test equipment support data.

Code S—Technical and Administrative Training. In-

WORK BREAKDOWN STRUCTURE CODE FOR FIRST AND THIRD POSITION

(1)	Position (2)	(3)	Description
A			Aircraft
	1		Fighters
		1	Basic Aircraft (Airframe)
		2	Engine
		3	Aircraft and Engine Accessories and Components
		4	Electronics and Communications Equipment
		5	Armament
		6	Support Equipment
		7	Other
	2		Bombers
		•	Same as for Fighters
	3		Transport
		•	Same as for Fighters
	4		Trainers
		•	Same as for Fighters
	5		Utility
		•	Same as for Fighters

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Validation of the Algorithm for Depot TCTO Labor Costs for CSCS (D160B)		5. TYPE OF REPORT & PERIOD COVERED Technical Report 6. PERFORMING ORG. REPORT NUMBER V-83-31859-12
7. AUTHOR(s) Dr. Sheldon J. Einhorn		8. CONTRACT OR GRANT NUMBER(s) F33600-82-C-0543
9. PERFORMING ORGANIZATION NAME AND ADDRESS Information Spectrum, Inc 1745 S. Jefferson Davis Highway Arlington, VA 22202		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS HQ AFLC/MML(VAMOSC) Wright-Patterson AFB, OH 45433		12. REPORT DATE April 1984 13. NUMBER OF PAGES 42
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

VAMOSC
O&S Costs
Cost Allocation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study is the twelfth of a set of reports documenting the findings of a study conducted by Information Sepctrum, Inc (ISI) for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the algorithm for Depot TCTO Labor Costs within the Component Support Cost System (CSCS) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Cost system. CSCS deals with subsystems and components for aircraft.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. This report provides the verification of the algorithm called "Depot Time Compliance Technical Order (TCTO) Labor Costs." This algorithm for Depot TCTO Labor Cost calculates and presents depot TCTO labor costs separately from other direct labor costs. These costs are developed for each combination of aircraft MDS and depot. Base TCTO labor costs were discussed in an earlier report.

This volume presents ISIs conclusions and recommendations, and the comments of the Office of VAMOSC.

END

FILMED

9-85

DTIC